Best Practices for Technology Transition

Technology Maturity Conference
September 12, 2007

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Briefing Contents

- Knowledge Based Acquisition Model
- Knowledge is not just TRLs
- Objectives
- Private Industry Findings
- DOD Findings
- Recommendations

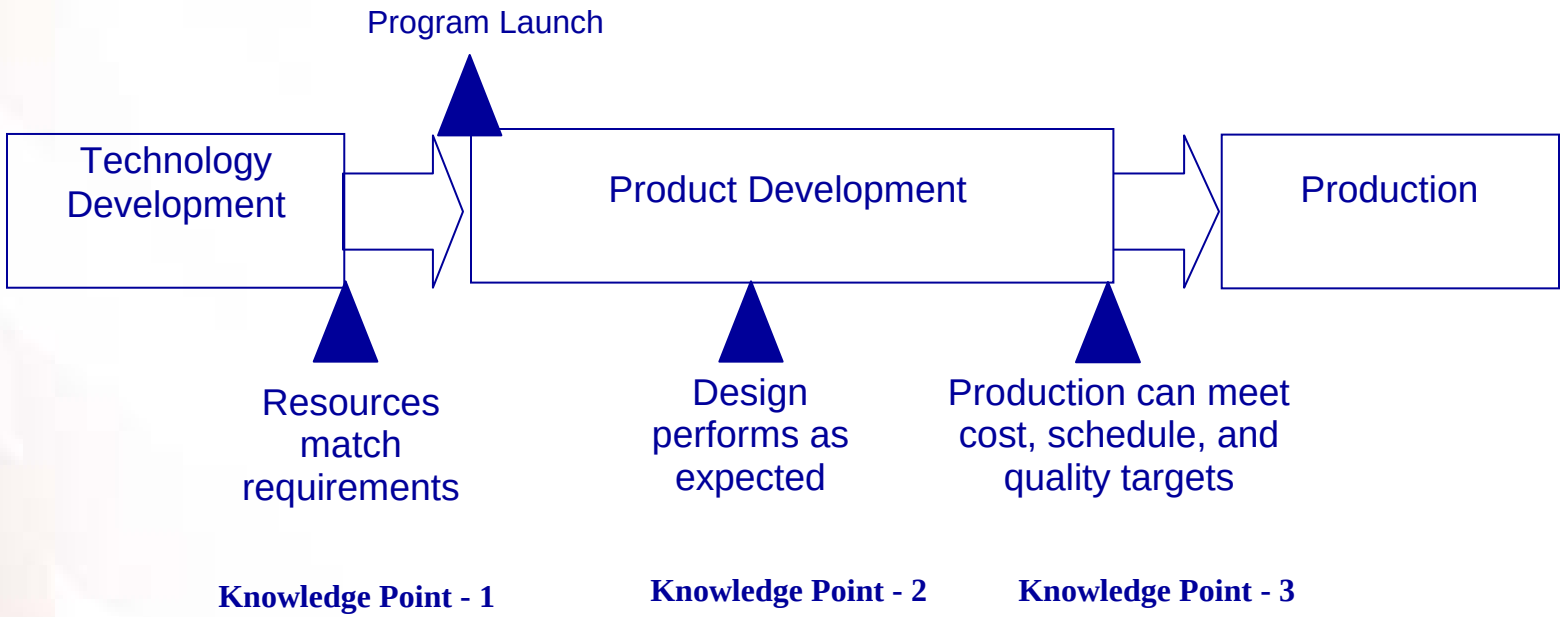
Knowledge Based Acquisition

Knowledge Point 1: Achieved when a sound business case is made, matching the customer's requirements with the developers resources in terms of knowledge, time, money and management capacity.

Knowledge Point 2: Achieved when a program determines that a product's design is stable—that is, it will meet customer requirements, as well as cost, schedule, and reliability targets.

Knowledge Point 3: Achieved when it has been demonstrated that the company can manufacture the product within cost, schedule, and quality targets.

Delivering the Product



Knowledge Point 1 is NOT Just TRLs

- Time & Money:
  - Cost and schedule estimates based on knowledge gained from preliminary design and systems engineering
  - Cycle times should be short and supported by evolutionary acquisition
  - Cost should be informed by risk and uncertainty analyses and presented as a range and not just a point estimate

- Requirements:
  - Informed by Systems Engineering
  - Clearly Defined and Understood
  - Stable

DOD Practices

- Time and Money:
  - Business case cost and schedule estimates are not well informed
  - Long cycle times make it difficult to accurately predict delivery or total cost
  - Baseline cost estimates presented at a “50%” confidence level without risk and uncertainty analysis
  - Characterized by a mindset that says “we can fix it in the next FYDP”
- Requirements:
  - Not well defined or understood, e.g. FCS, JTRS
  - Requirements creep is the norm, e.g. Global Hawk
  - Long cycle times provide opportunity for requirements creep

Past GAO Recommendations to DOD to Improve Outcomes

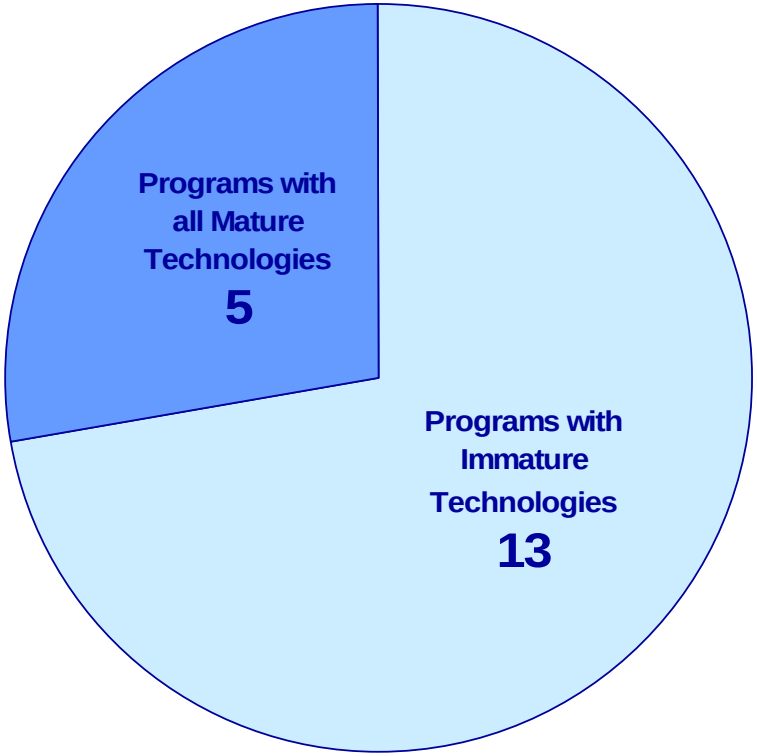
- Implement a disciplined, knowledge-based review process prior to starting product development.
- Require increasingly precise cost, schedule, and performance information that meets specified levels of confidence and allowable deviations at each decision point prior to initiating product development.
- Bring knowledge about resources (time, money, and technologies) and requirements together early to inform trades and manage the portfolio.
- Assign and empower a single point of accountability to ensure the success and balance of the entire acquisition portfolio.
- Require that technologies demonstrate a high readiness level—TRL 7—before Milestone B of a major acquisition.

Despite Constructive Policy Changes, Implementation is Still A Challenge

- **DOD 5000 policy says most of the right things about separating technology development from system development**
  - Calls for technology maturity to TRL 6 (relevant environment)
  - Calls for evolutionary approach as a check on requirements.
  - Short development cycle times (5 years or less)

- **However,**
  - Best practice standard is TRL 7 (operational environment)
  - Most individual programs do not even abide by policy
  - Many programs fall outside: satellites, MDA, ships
  - Those within are unique: e.g., FCS, JSF
  - Preference is still for revolutionary, not evolutionary
  - Knowledge gaps and optimistic estimates at MS B are the norm and are reinforced with approval and funding

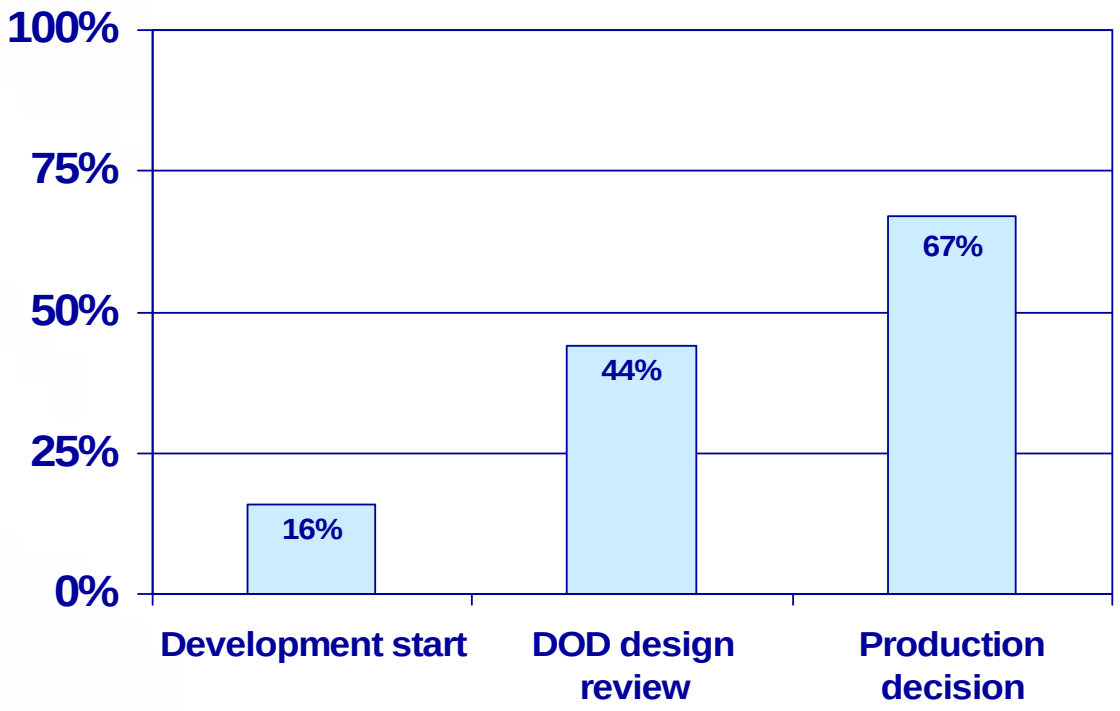
Technology Maturity for 18 Programs Initiated the Revised Acquisition Policy



Note: Maturity measured against the DOD standard of TRL 6

Source: GAO-06-368

Percentage of Programs that Achieved TRL 7 at Key Junctures



Note: If DOD's standard of TRL 6 is used 32% of the programs entered development with all their technologies mature.

Source: GAO-07-406SP

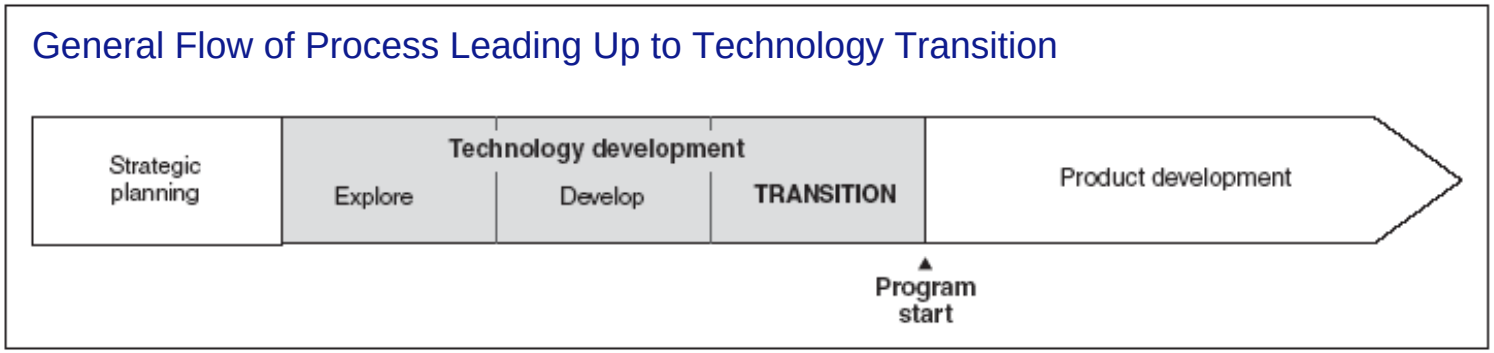
Best Practices for Technology Transition Report Objectives

- Identify techniques used by leading private companies to transition mature technologies to product lines by product launch.
- Assess practices used by the military services to transition technology.
- Determine potential technology transition practices DOD could use to improve its weapon systems outcomes.

Private Industry Findings

- Merge technology development and product development activities prior to product launch.
- Have strong strategic planning to prioritize technology needs and a structured technology development process.
- Use 3 tools to support technology transition:
  - Relationship managers
  - Technology Transition Agreements
  - Metrics

Private Industry Findings – Merge Technology and Product Development



Source: GAO analysis and presentation of leading companies' practices.

- Hybrid phase used to merge technology development and product development activities prior to product launch.
- Responsibilities for managing and funding technology development gradually shift from labs to product line during this phase.

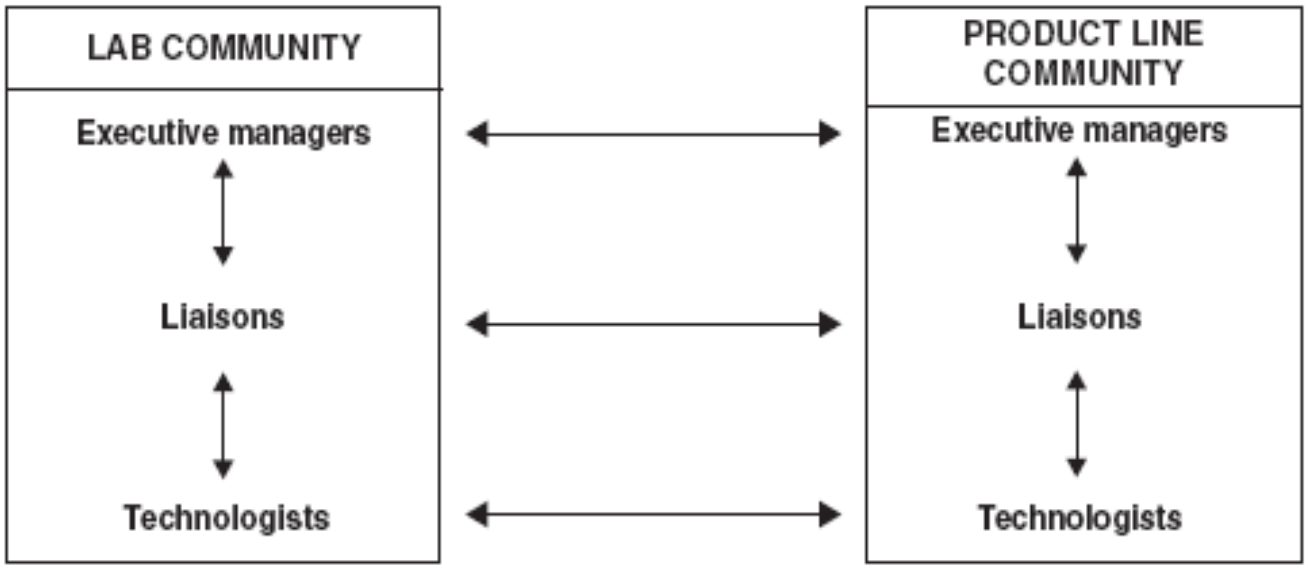
Private Industry Findings – Precursors to Smooth Transition

- Strong strategic planning processes used to identify and react to market needs quickly.
- Structured, gated technology development process.

TECHNOLOGY DEVELOPMENT GATES		
Explore Technology ideas and concepts are being explored	**Develop** Technology development activities are underway	**Technology transition** Technology is ready to transition from lab to product line team
Review	*Review*	
Deliverables • Technology is consistent with overall business strategy • Technology is promising and is likely to meet needs for potential product lines • Lab identifies potential products where technology can be used • Key cost, benefit, risk, marketing, manufacturing, and life cycle management issues are identified • Scalability approaches are identified • Technologies considered to be intellectual property are identified	**Deliverables** • Technology is consistent with technology strategy and other relevant strategies • Labs have high degree of confidence the technology will work • Product line team agrees that the technology will meet its needs • Technical requirements are identified • Cost, benefits, and risks are quantified • Scalability approach is selected • Strategies for addressing intellectual property rights are selected	**Deliverables** • Technology project complies with technology strategy • Technology is sound • Technology meets product requirements • Cost, benefit, and risks are well understood • Technology can be scaled to a magnitude appropriate for practical application • Product line team agrees technology is ready • Intellectual property rights methods have been pursued • Technology is demonstrated in an operational environment • Technical documentation is ready to be given to product line team

Private Industry Findings – Use of Relationship Managers

Relationship managers from labs and product lines serve as a communication link between the two communities and work out transition issues.



Source: Motorola; GAO (analysis and presentation).

Private Industry Findings – Use of Technology Transition Agreements

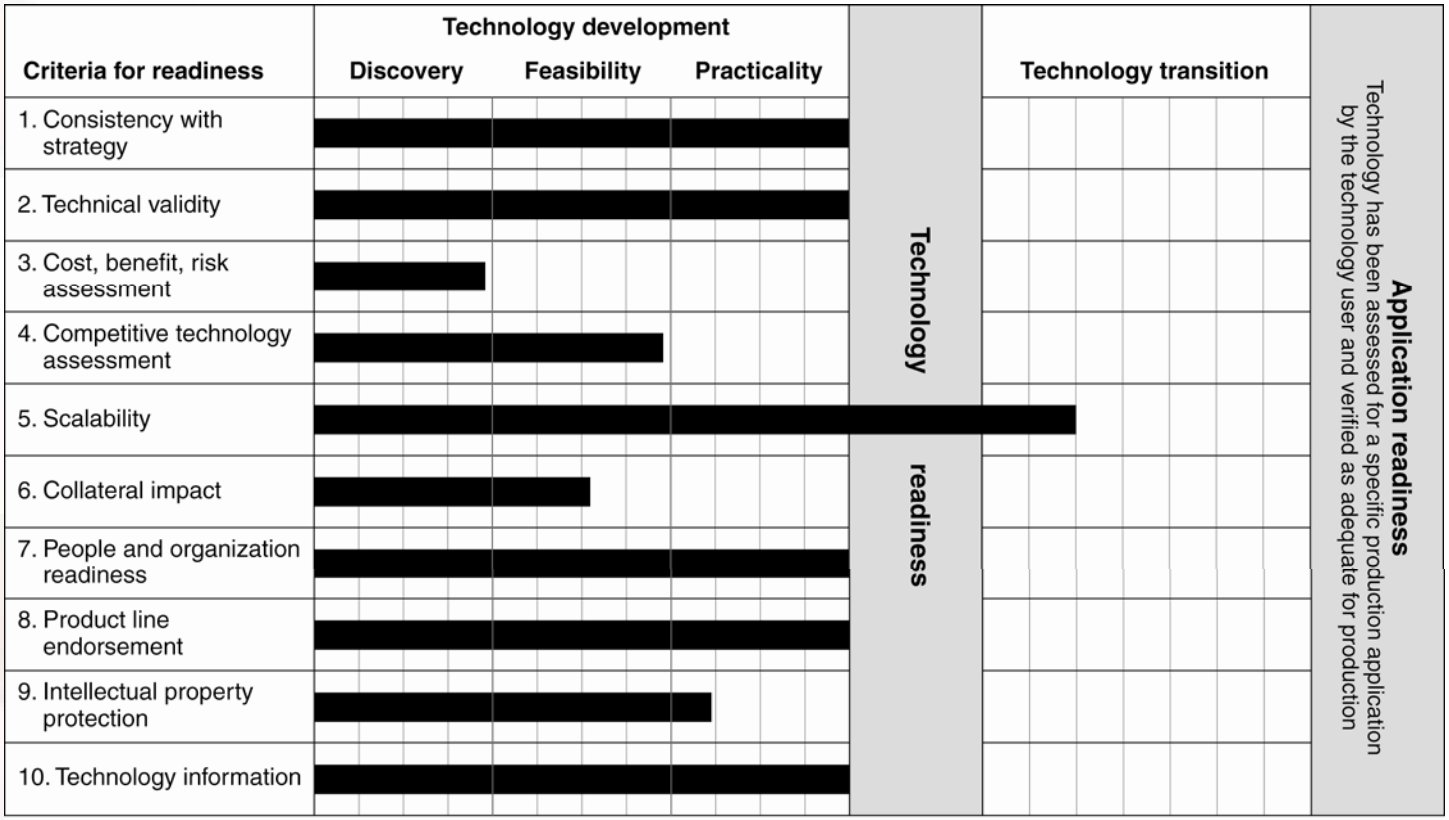
- Technology transition agreements document decisions made between labs and product lines:
  - Contain specific quantifiable cost, schedule, performance, and manufacturability metrics the labs must demonstrate before product line acceptance.
  - Feasibility, relevancy, and application of each technology are assessed in order to identify potential barriers to transition.
  - Identify lab and product line funding commitments.
  - May include loaning key lab technologists to the product line.

Private Industry Findings – Use of Project and Process Metrics

- Project metrics used to assess the status of technology development and whether the technology meets product needs
  - Size, weight, power, and reliability, as well as nonrecurring development and/or manufacturing costs.

- Process metrics provide information on the status, timeliness and impact of technology development efforts.
  - Return on investment, cycle time, technology yield, number of technologies commercialized, customer survey results.

Notional Boeing Technology Maturity Scorecard for a Hypothetical Technology



Source: GAO analysis based on The Boeing Company's scorecard.

DOD Findings

- DOD does not adequately prioritize the technologies that are most critical to acquisition programs.
- DOD does not merge S&T and product line activities prior to product launch; Transition often occurs at product launch irrespective of whether technologies are mature.
- New tools to support transition are being used, but:
  - Not as comprehensive as industry best practices.
  - Use is not widespread.

DOD Findings – DSB Report

"Immature technologies and manufacturing challenges have a significant impact on DOD's ability to rapidly and affordably transition technology to the war fighter."

"S&T program managers often believe that affordability and manufacturing issues are not relevant concerns in 6.3 programs, focusing instead on fabrication of test and evaluation and prototype articles. But this line of thinking leads to higher costs later in a program, when manufacturing concerns are addressed after technical designs are considered 'ready.' "

"In order to achieve the objective of lower cost equipment, manufacturing concerns must be addressed earlier in the program life cycle. Production and support costs need to become a component of key technical design requirements, before the final stages of development when technologies are released for prototyping."

Source: Defense Science Board study (data); GAO (presentation and analysis).

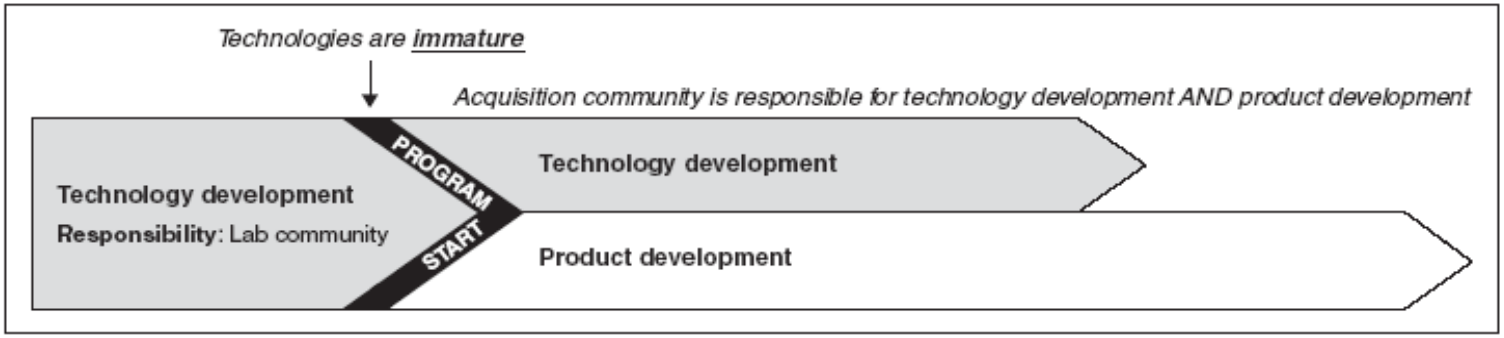
DOD Findings – Underdeveloped Technology Prioritization and Development Processes

DOD is not well positioned to develop and mature needed technologies on time.

- Strategic planning process does not consistently prioritize technologies most critical to acquisition programs.
- Military services have established S&T boards to select and oversee new technology projects, which increases visibility for some technologies, but the scope varies across military services.

DOD Findings – Technology and Product Development are not Effectively Aligned

DOD does not have a structured, gated S&T technology development process with deliverables to guide investments.



Source: DOD (data); GAO (analysis and presentation).

- S&T and acquisition communities do not communicate well and are not aligned in a way to effectively meet priorities, resulting in:
  - Irrelevant technologies advancing to final stages of lab development without commitment to field the technologies.
  - Technology not being ready to transition when needed.
  - Acquisition not being prepared to take over funding responsibilities.

DOD Findings – Tools to Support Technology Transition are Underutilized

- Relationship Managers
  - Generally used to market lab technology; not as a communication tool to assist in technology transition.
- Technology Transition Agreements
  - Use and coverage vary greatly among service S&T programs
  - Agreements contain some of the same elements seen in industry, but typically do not require the technology developer to demonstrate cost metrics.
  - Tool used mainly by labs; not valued by acquisition community as highly.
- Metrics
  - Few metrics used to gauge the impact of investments or the effectiveness of processes used to develop and transition technologies.

DOD Findings: Some Promising Initiatives to Aid Transition

- **Advanced Concept/Joint Concept Technology Demonstration** (ACTD/JCTD) -- Goal is to get technologies that meet critical needs to users faster and at lower cost, refine the the selection process to better match user priorities, and provide more funding in early stages of demonstration.
- **Manufacturing Technology Program** -- Aimed at quickly identifying and solving technology transition problems; focusing on affordable, low-risk development and production
- **Foreign Comparative Testing & Technology Transition Initiative** -- FCT identifies, evaluates, and procures technologies developed by other countries. TTI speeds transition of DOD lab developed technologies to acquisition programs.

Recommendations

- Develop a gated process for developing and transitioning technologies that establishes a transition phase and defines activities that should occur during this phase.
- Set aside a portion of advanced component development and prototype funds for the S&T to manage the transition of technologies to acquisition programs.
- Expand the use of technology transition agreements to applied and advanced development projects.
- Include additional metrics in technology transition agreements.
- Expand the use of relationship managers and define responsibilities.
- Adopt additional process-oriented metrics to measure the effectiveness of S&T processes and the impact of S&T investments.